

CaFe: SHMS Hodoscope HV Study

“Identifying Issue in Data”

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Aug 23, 2022

The following slides ONLY cover issues observed with the data.

For motivation of the SHMS Hodo HV study, please refer to:

https://hallcweb.jlab.org/wiki/images/9/93/SHMS_PaddleOFF_for_CaFeStudy.pdf

https://hallcweb.jlab.org/wiki/images/5/5b/SHMS_PaddleOFF_for_CaFeStudy_part2.pdf

https://hallcweb.jlab.org/wiki/images/a/a7/SHMS_PaddleOFF_for_CaFeStudy_part3.pdf

Identify Potential Issue in Data

During CaFe Optics/Elastics run (Aug 08, 2022), an incident happened during our last run 16037, which is investigated in the slides that follow

HC-Log Entry (Aug 08 Swing) : <https://logbooks.jlab.org/entry/4025938>

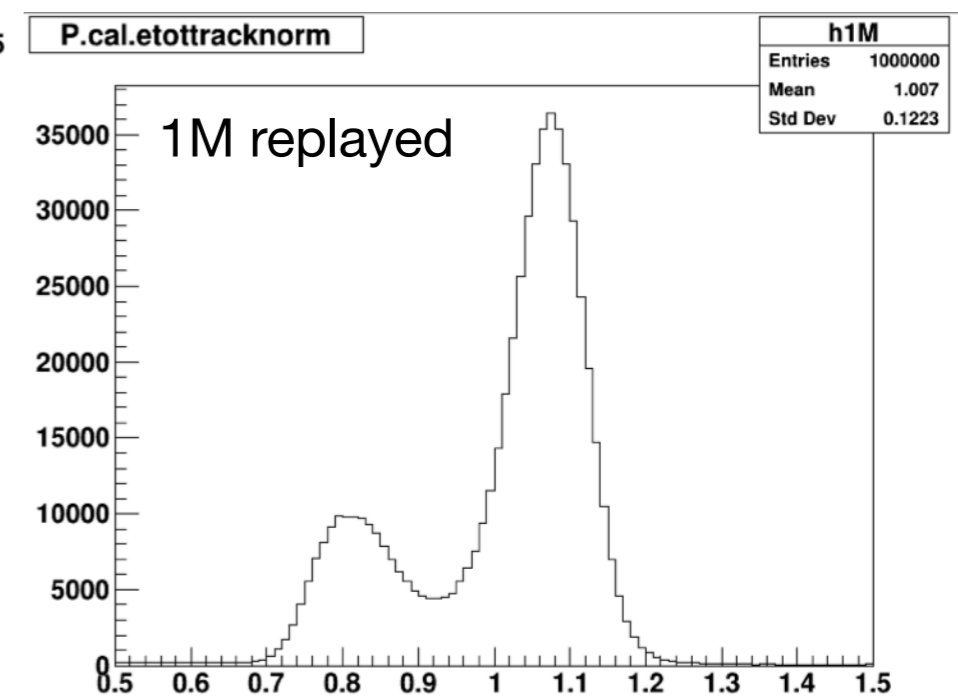
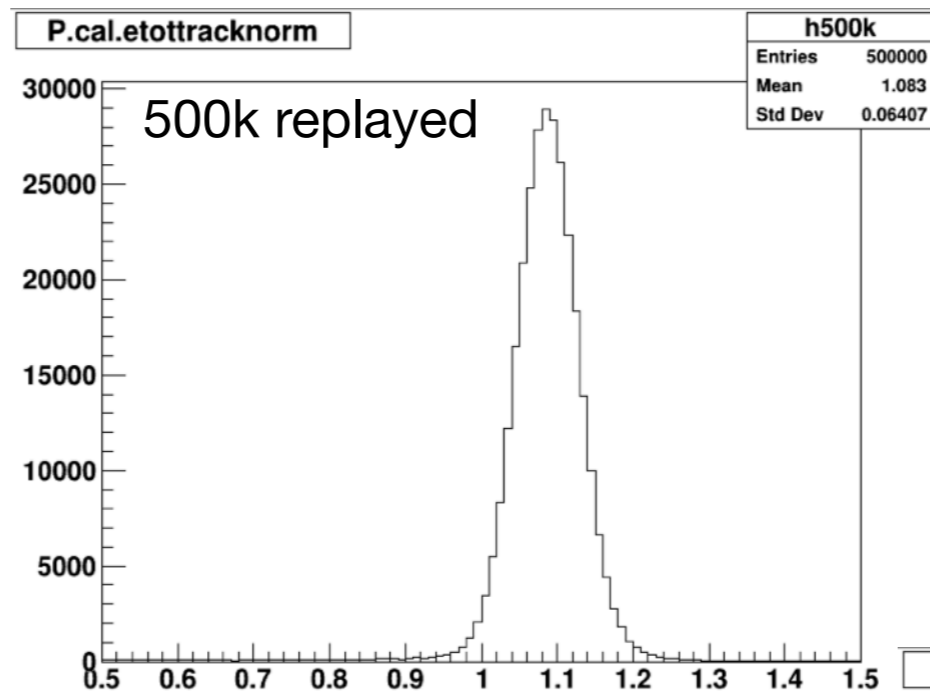
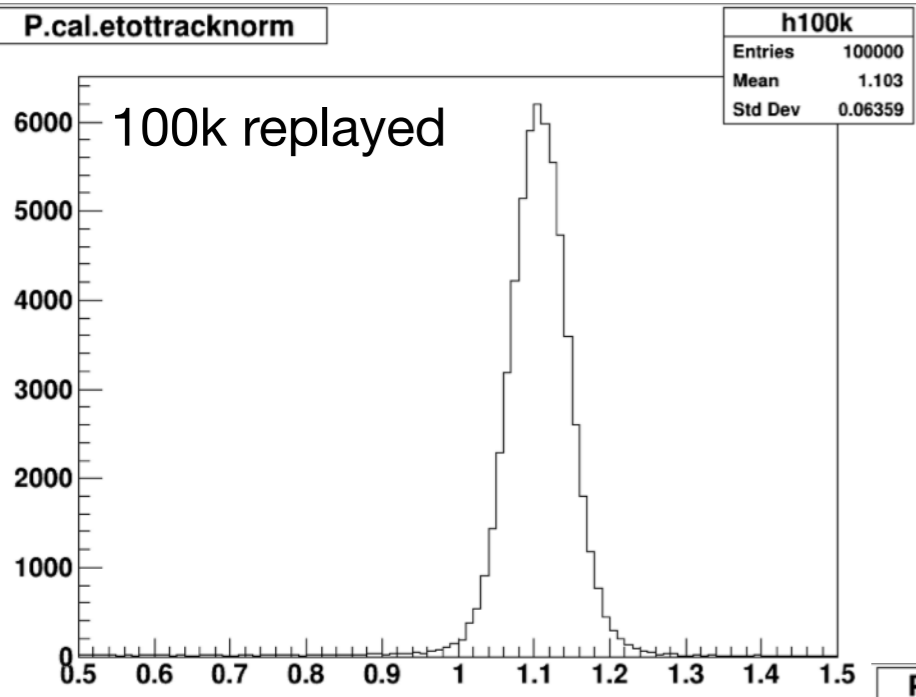
Run 16037 -- CaFe Heep SHMS Hodo HV Test, Turned off S1X[1-6] S2X[1-6], 25uA. <https://logbooks.jlab.org/entry/4026086>

During this run, GH starts setting up the HMS for the next momentum, as per Jacob's instructions. PS4=-1.

21:00 -- Shortly after the beginning of this run, MCC calls to ask what we changed. It seems that changing the HMS caused the beam spot to move on the dump.

A bit surprising, since the angle is 12.50deg. The HMS fringe field at this momentum must be huge!

Almost immediately after, HMS Q3 trips. <https://logbooks.jlab.org/entry/4026088>

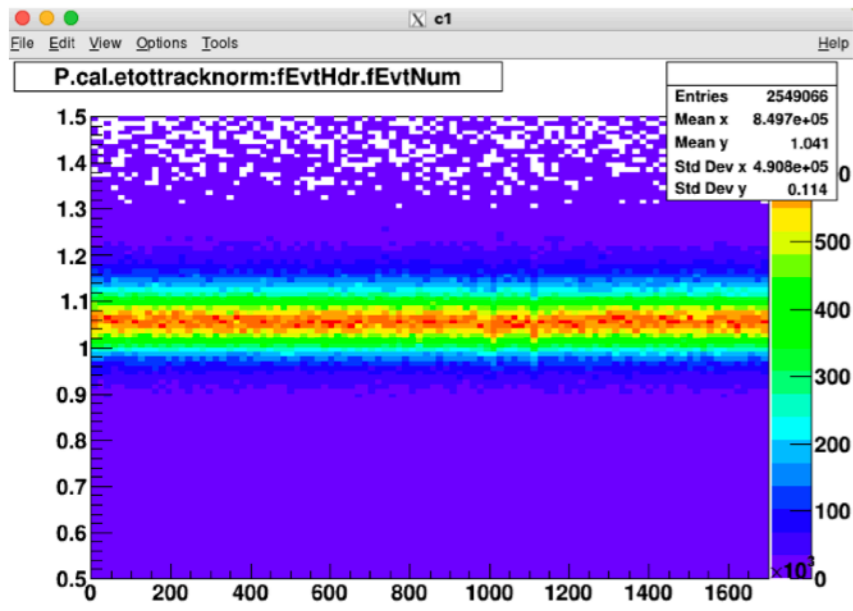


* somewhere between 500k and 1M, a weird bump starts to show up

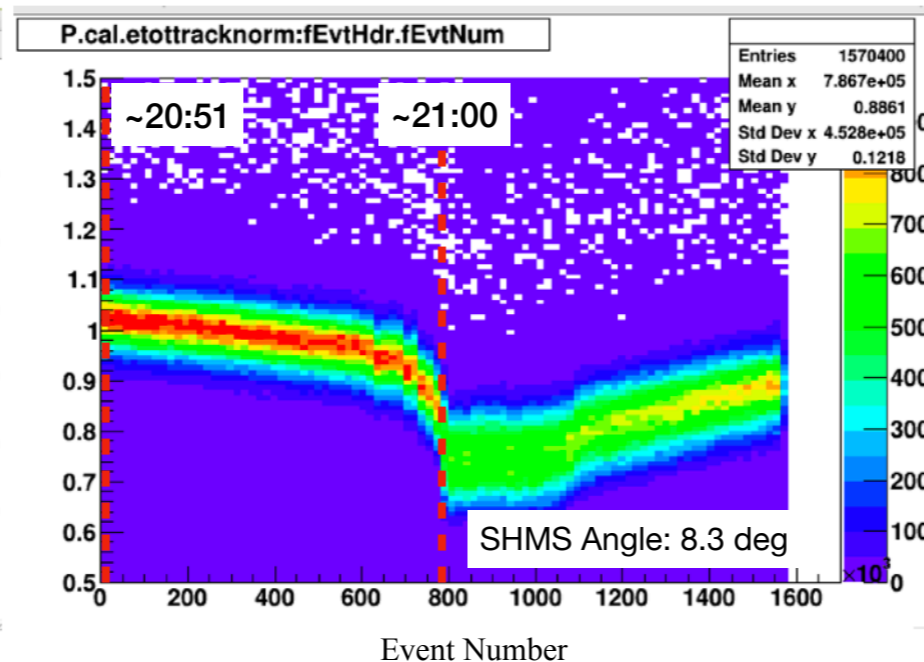
* I tried calibrating calorimeter, but bump still show up

SHMS Calorimeter Energy Deposited / Track Momentum vs. Event Number

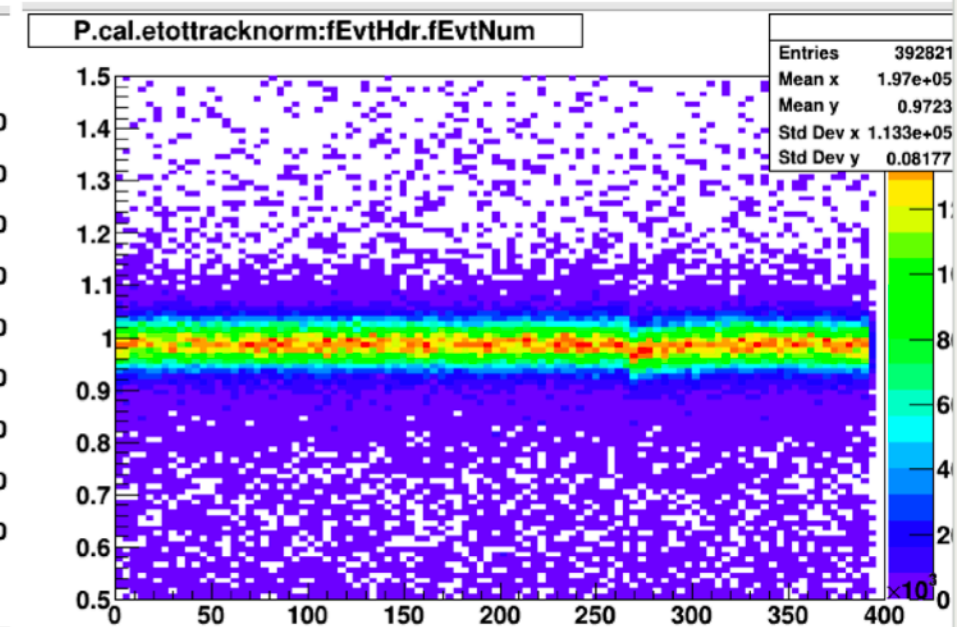
Run 16036 | time: 20:32 - 20:47



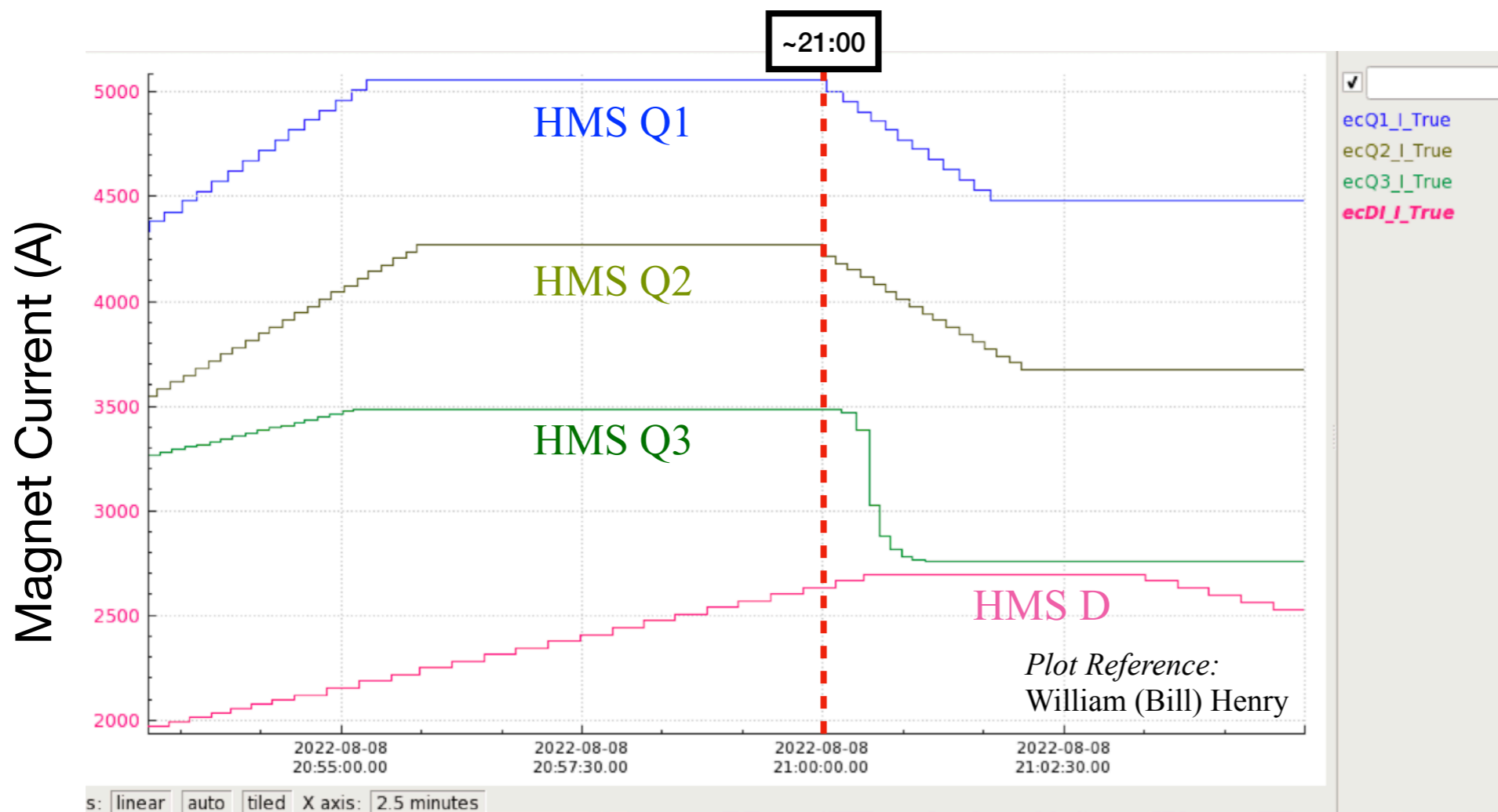
Run 16037 | time: 20:53 - 21:05



Run 16039 | time: 21:44 - 21:47



HMS Magnets Current Ramp-Up



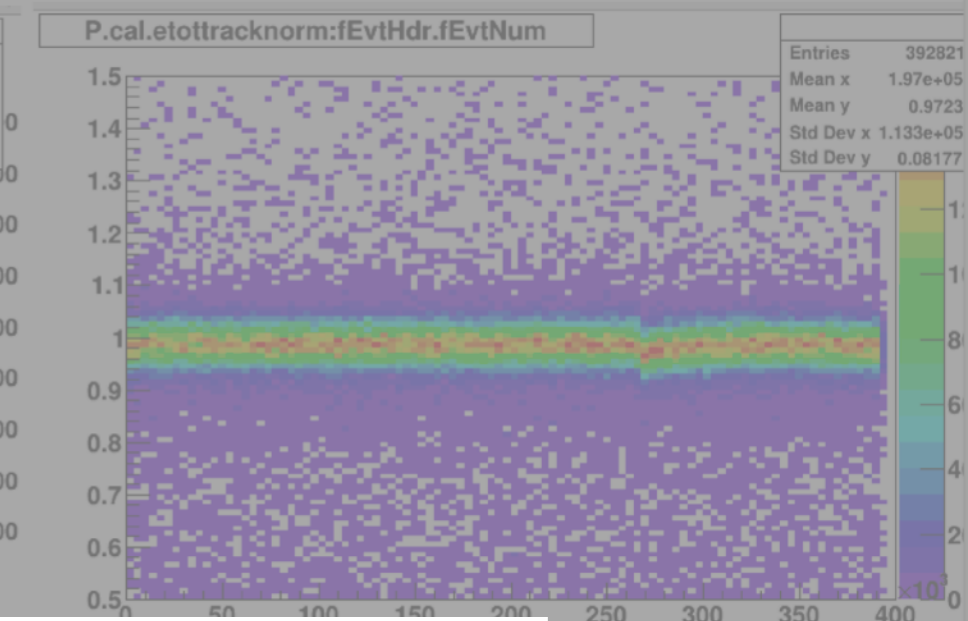
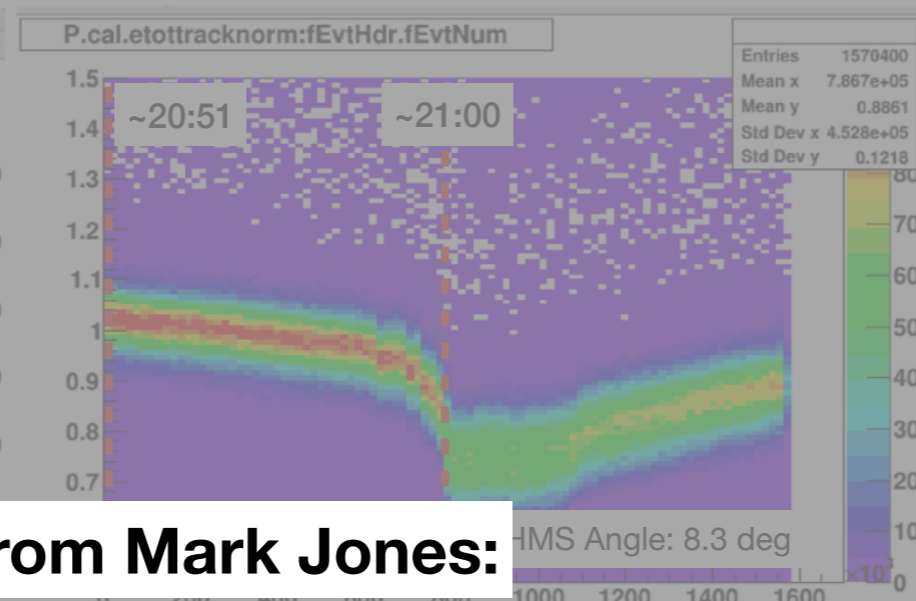
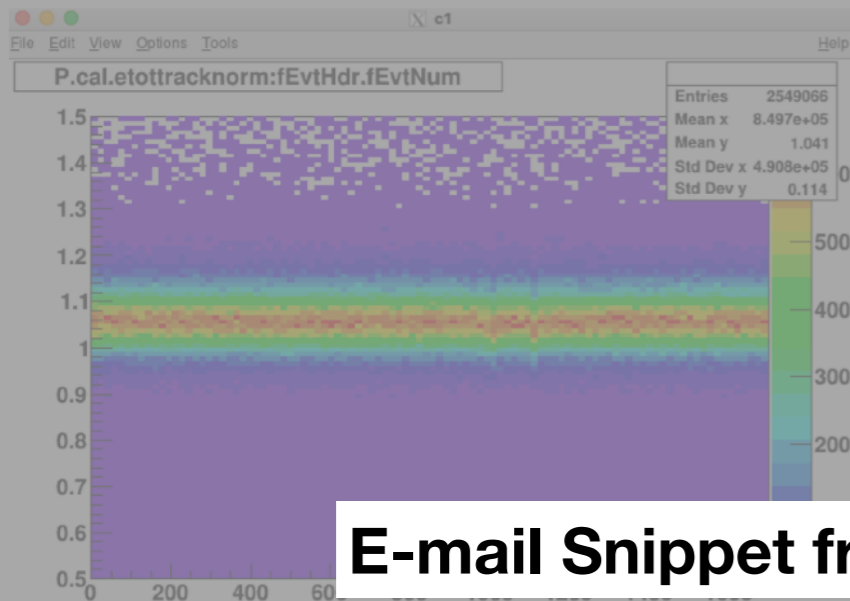
HMS Angle: 12.5 deg
HMS Momentum: 6.79 GeV/c

SHMS Calorimeter Energy Deposited / Track Momentum vs. Event Number

Run 16036 | time: 20:32 - 20:47

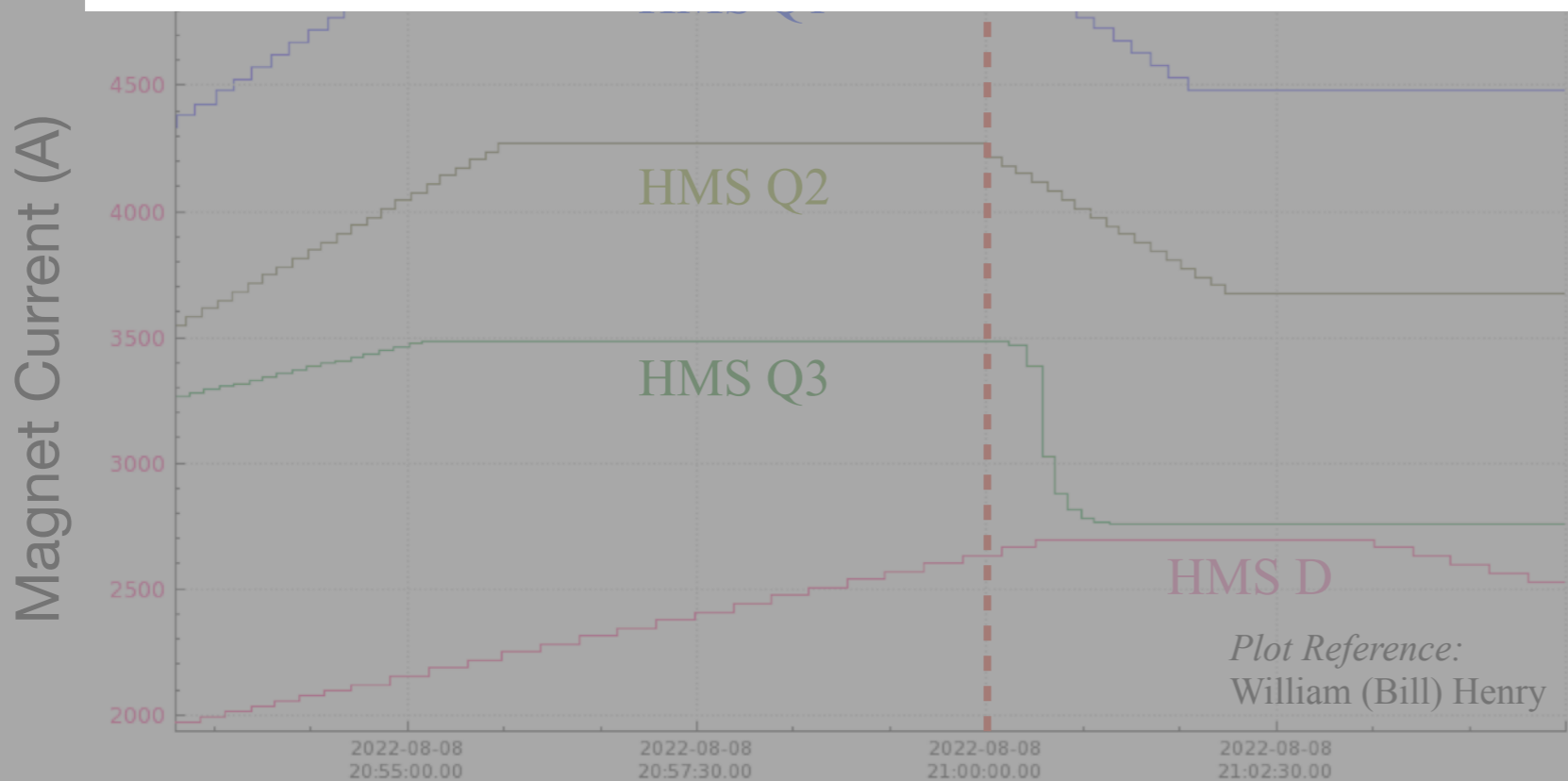
Run 16037 | time: 20:53 - 21:05

Run 16039 | time: 21:44 - 21:47



E-mail Snippet from Mark Jones:

I think that what happened is that the HMS was being set for a high momentum while the SHMS was taking data and the field from the HMS was effecting the SHMS calorimeter PMTs. The SHMS calorimeter PMT stick out of the back of the SHMS hut. I would look at the HMS currents during this run.



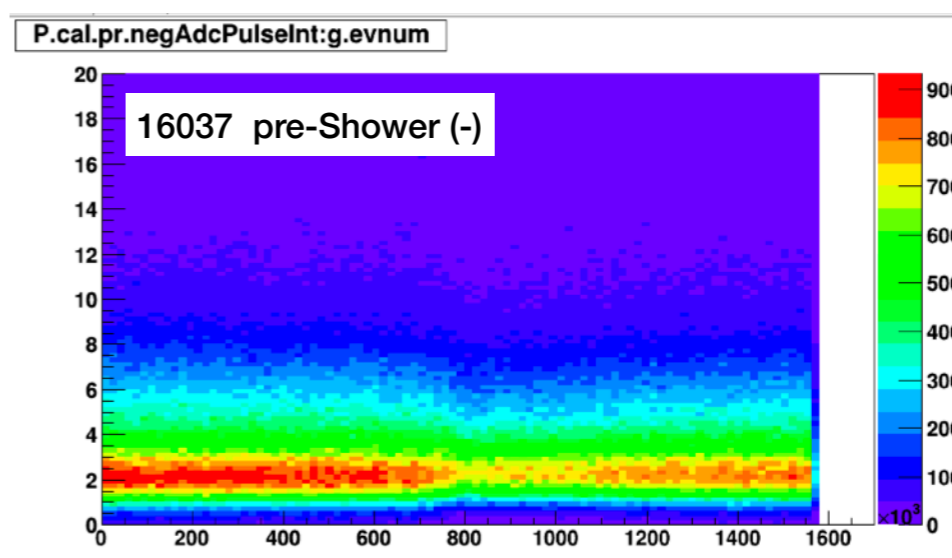
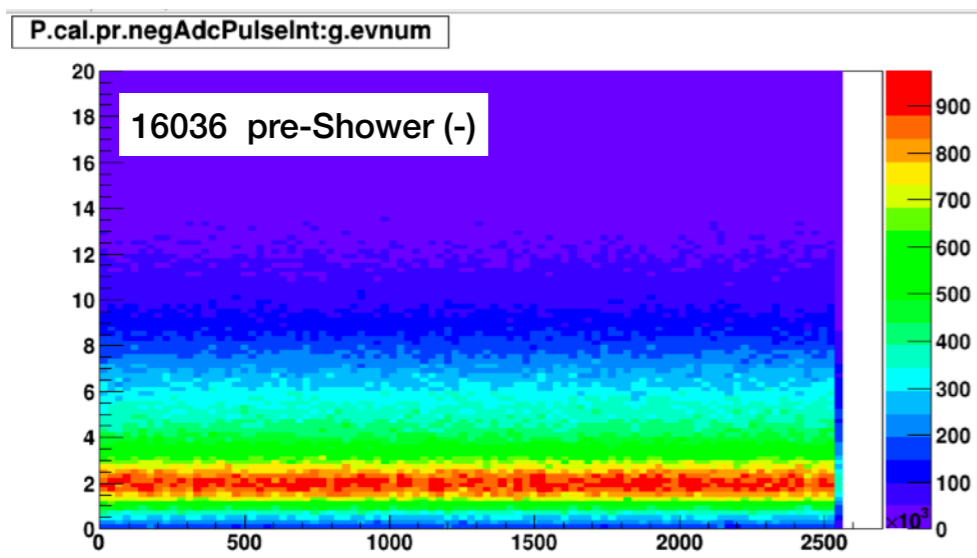
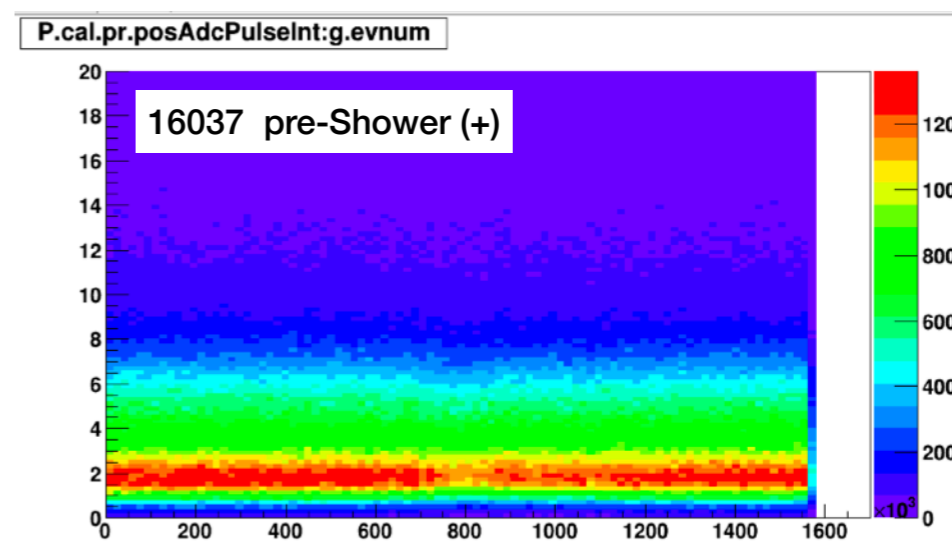
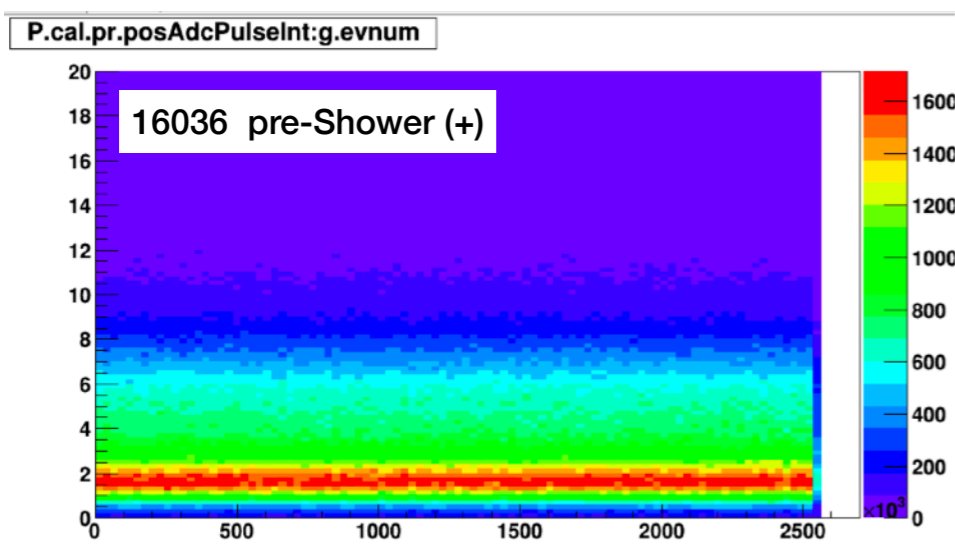
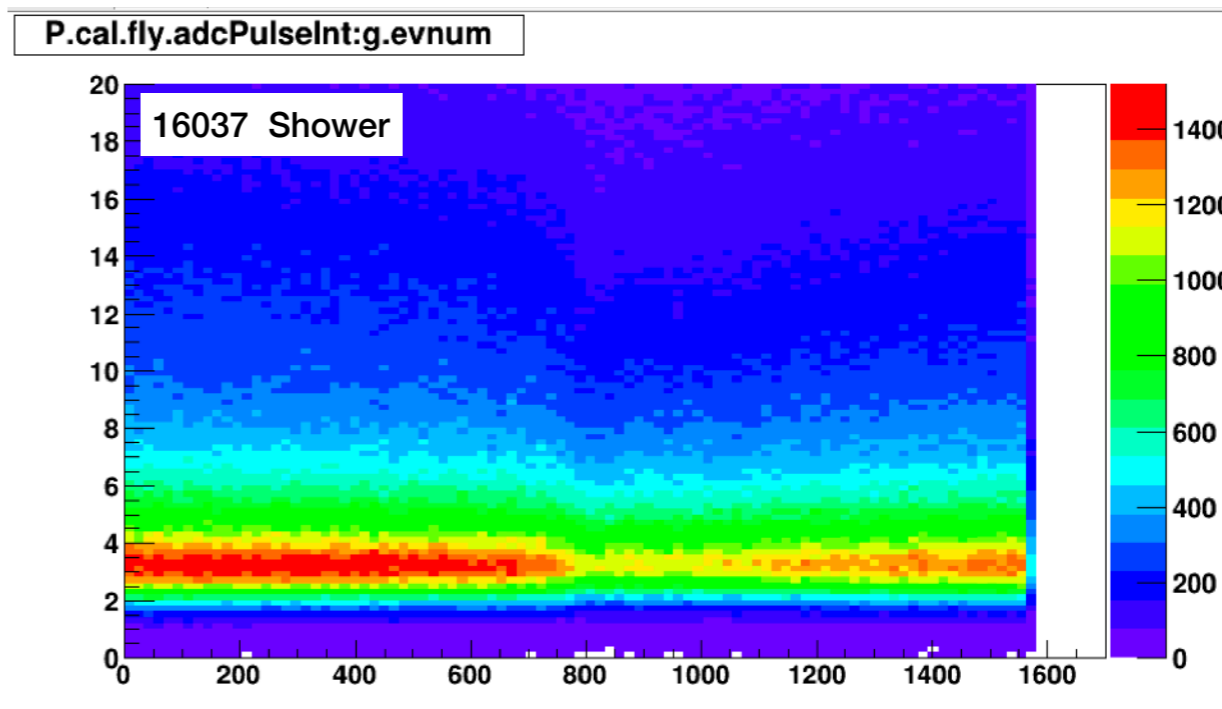
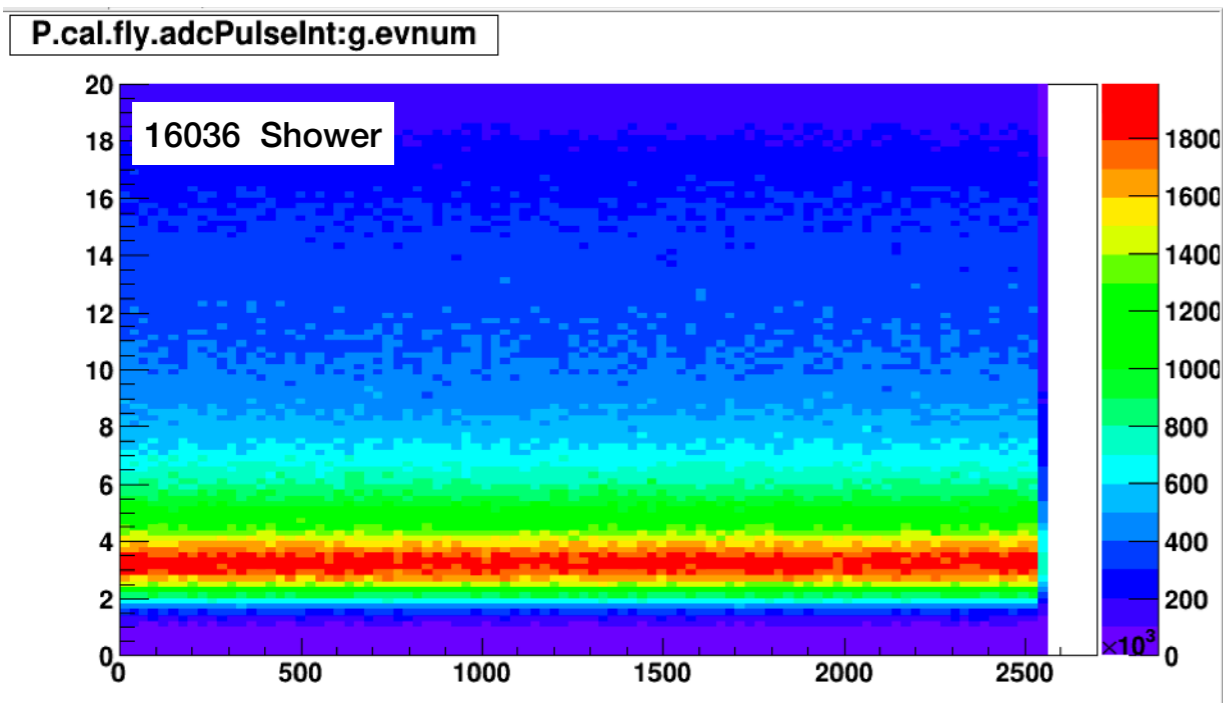
ecQ2_I_True
ecQ3_I_True
ecDI_I_True

HMS Angle: 12.5 deg
HMS Momentum: 6.79 GeV/c

Plot Reference:
William (Bill) Henry

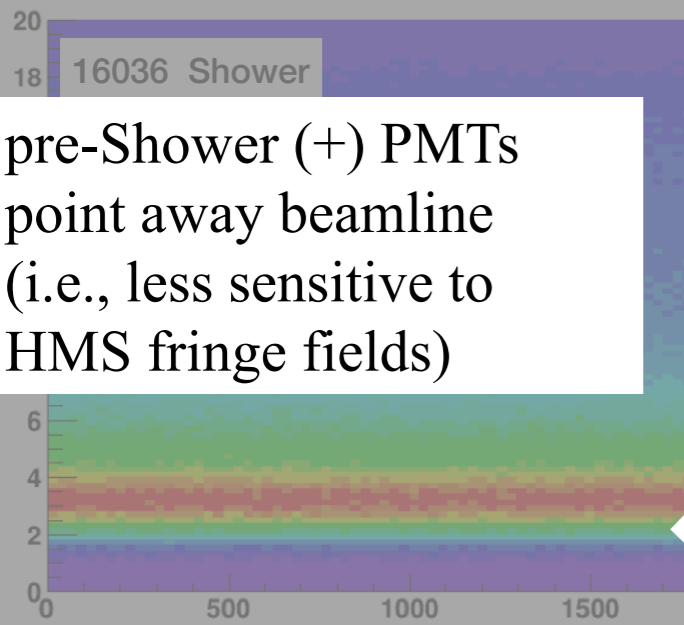
s: linear auto tiled X axis: 2.5 minutes

Calorimeter fADC Pulse Integral vs. Event Number



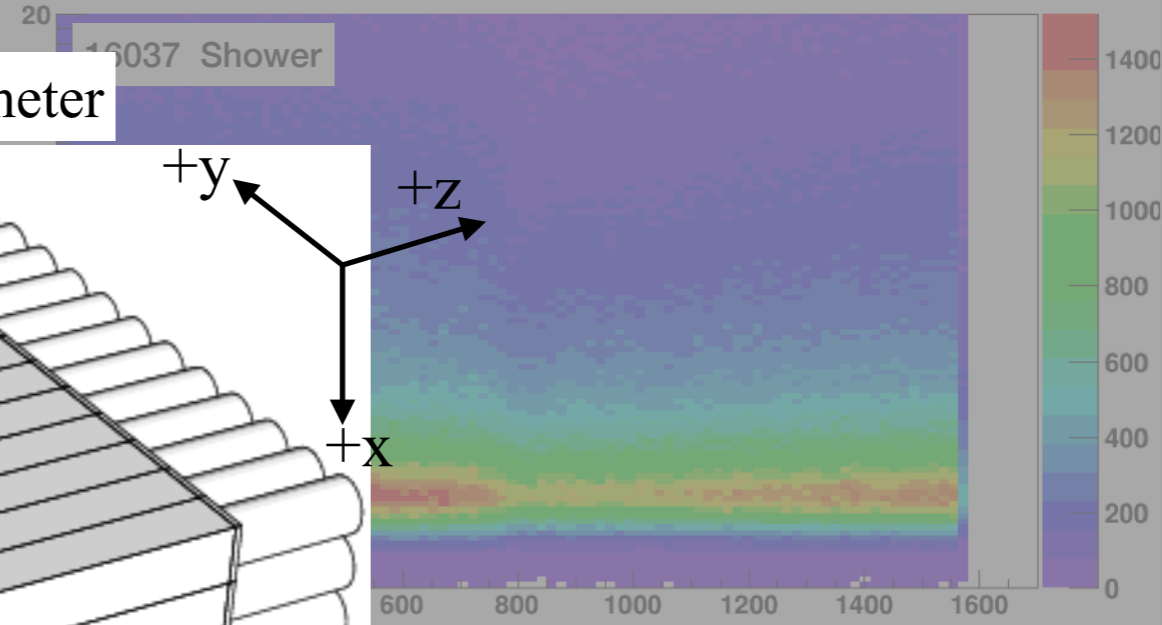
fADC Pulse Integral vs. Event Number

P.cal.fly.adcPulseInt:g.evnum

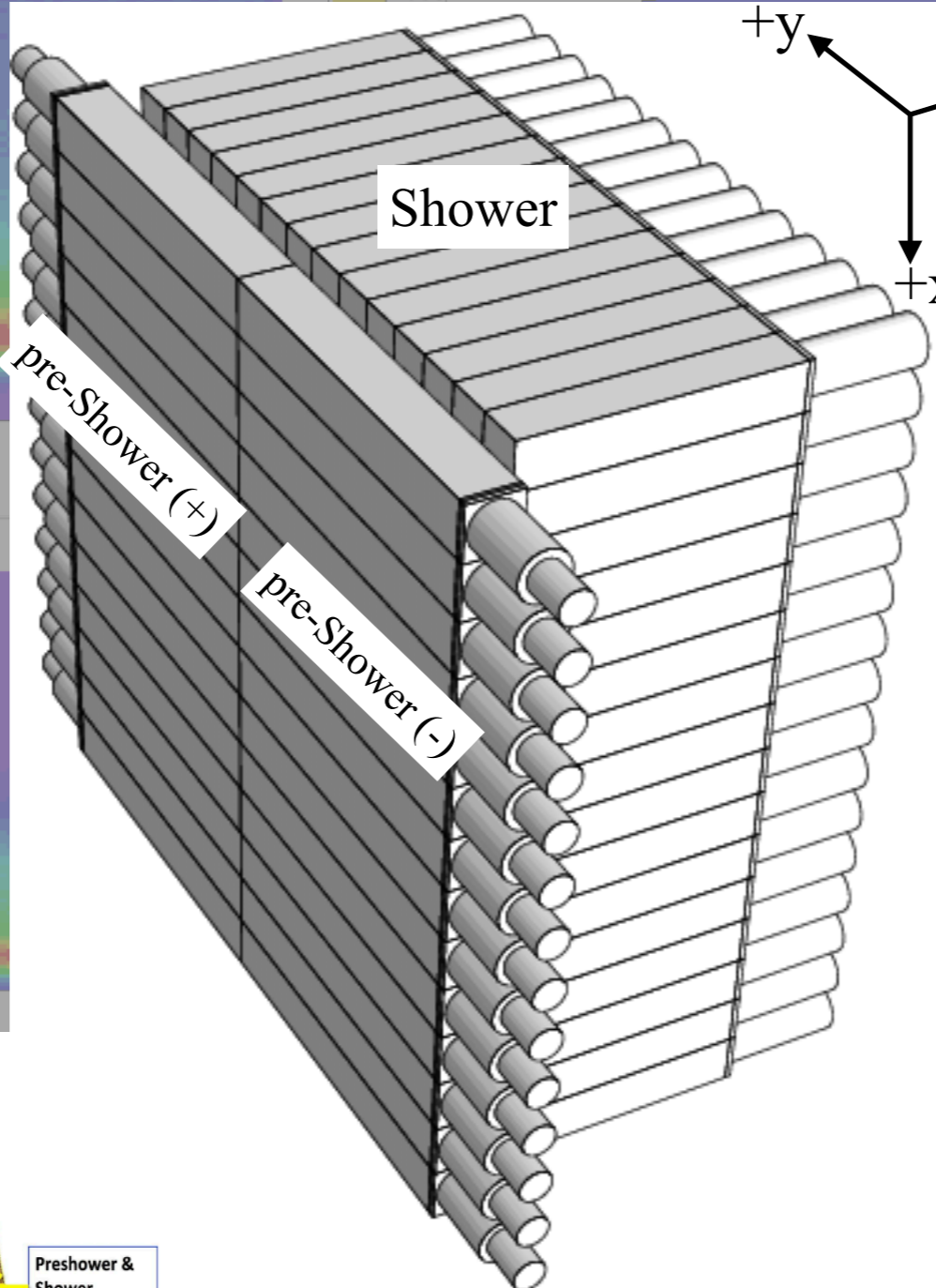


pre-Shower (+) PMTs point away beamline (i.e., less sensitive to HMS fringe fields)

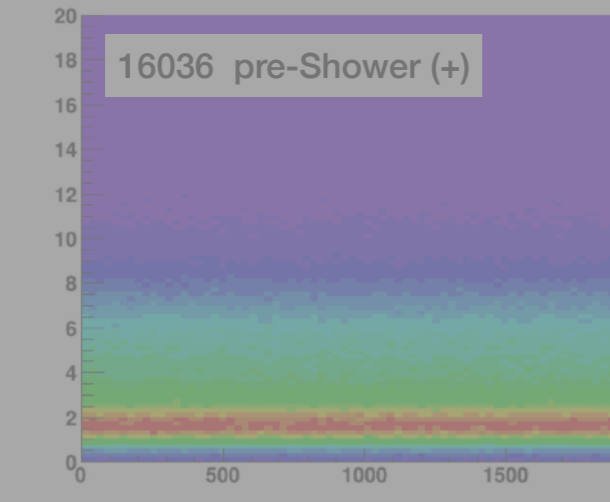
P.cal.fly.adcPulseInt:g.evnum



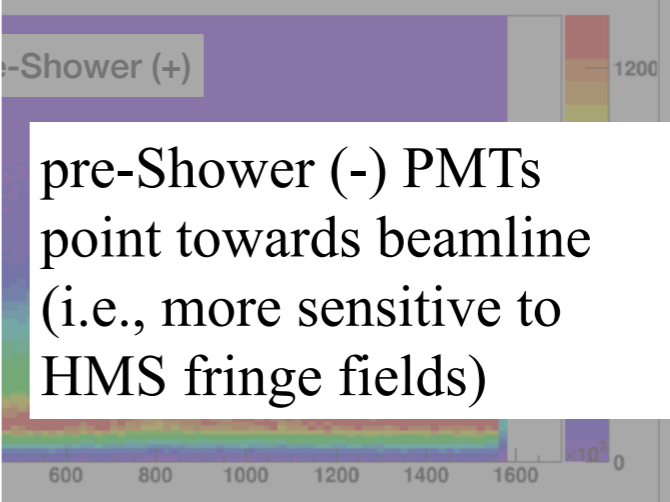
SHMS Calorimeter



P.cal.pr.posAdcPulseInt:g.evnum

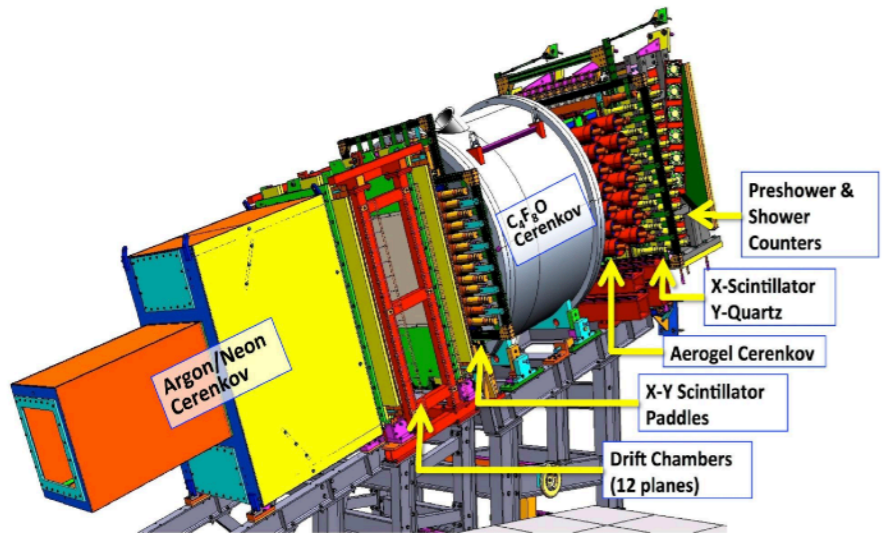


t:g.evnum

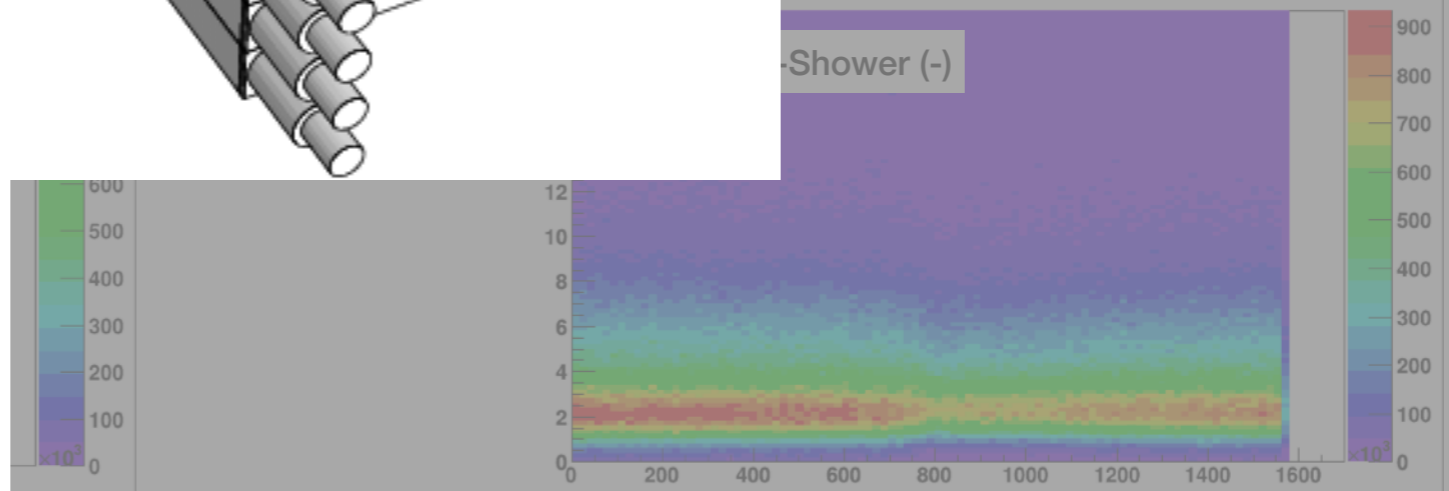


pre-Shower (-) PMTs point towards beamline (i.e., more sensitive to HMS fringe fields)

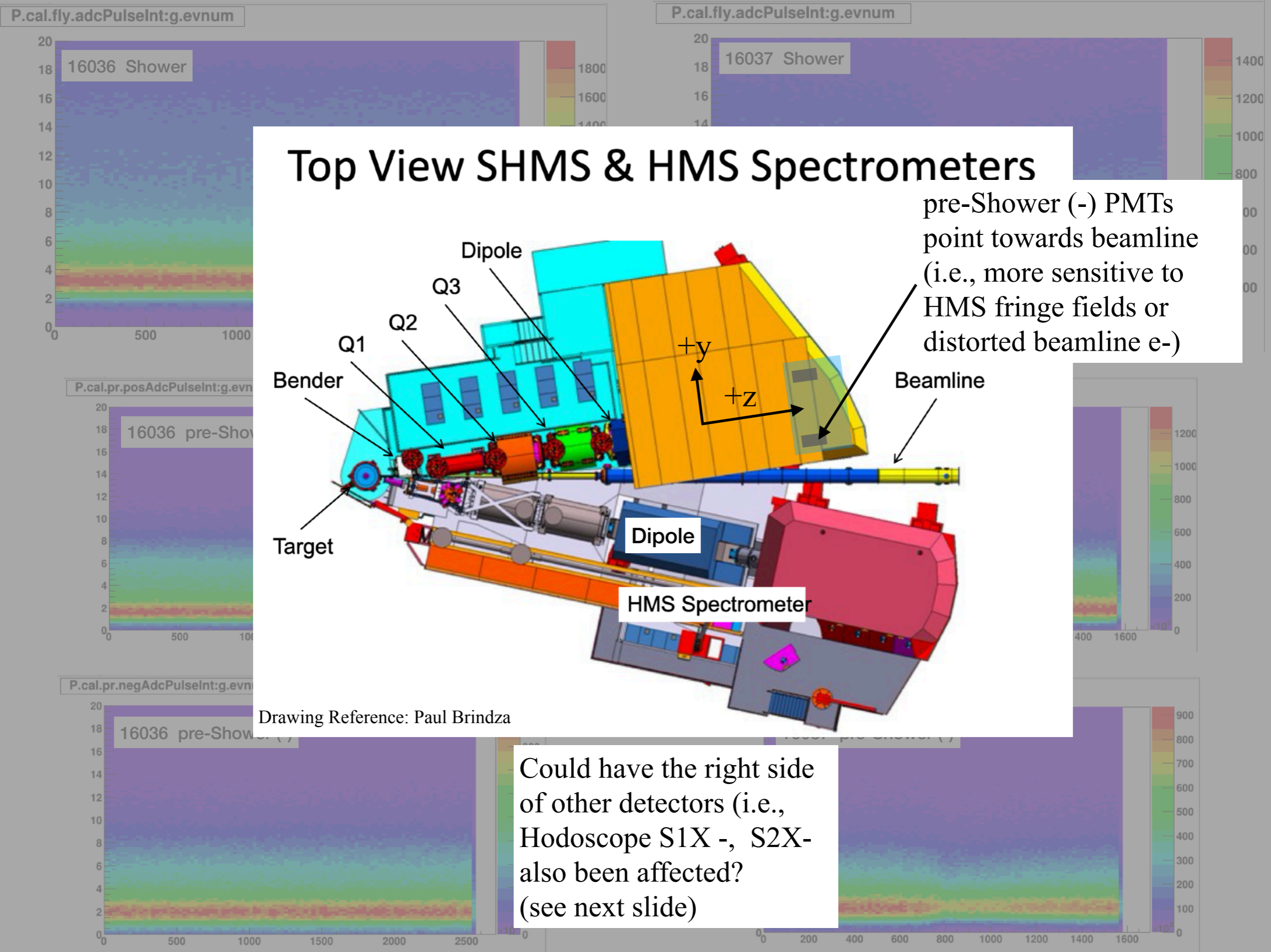
Particle Detectors inside the SHMS



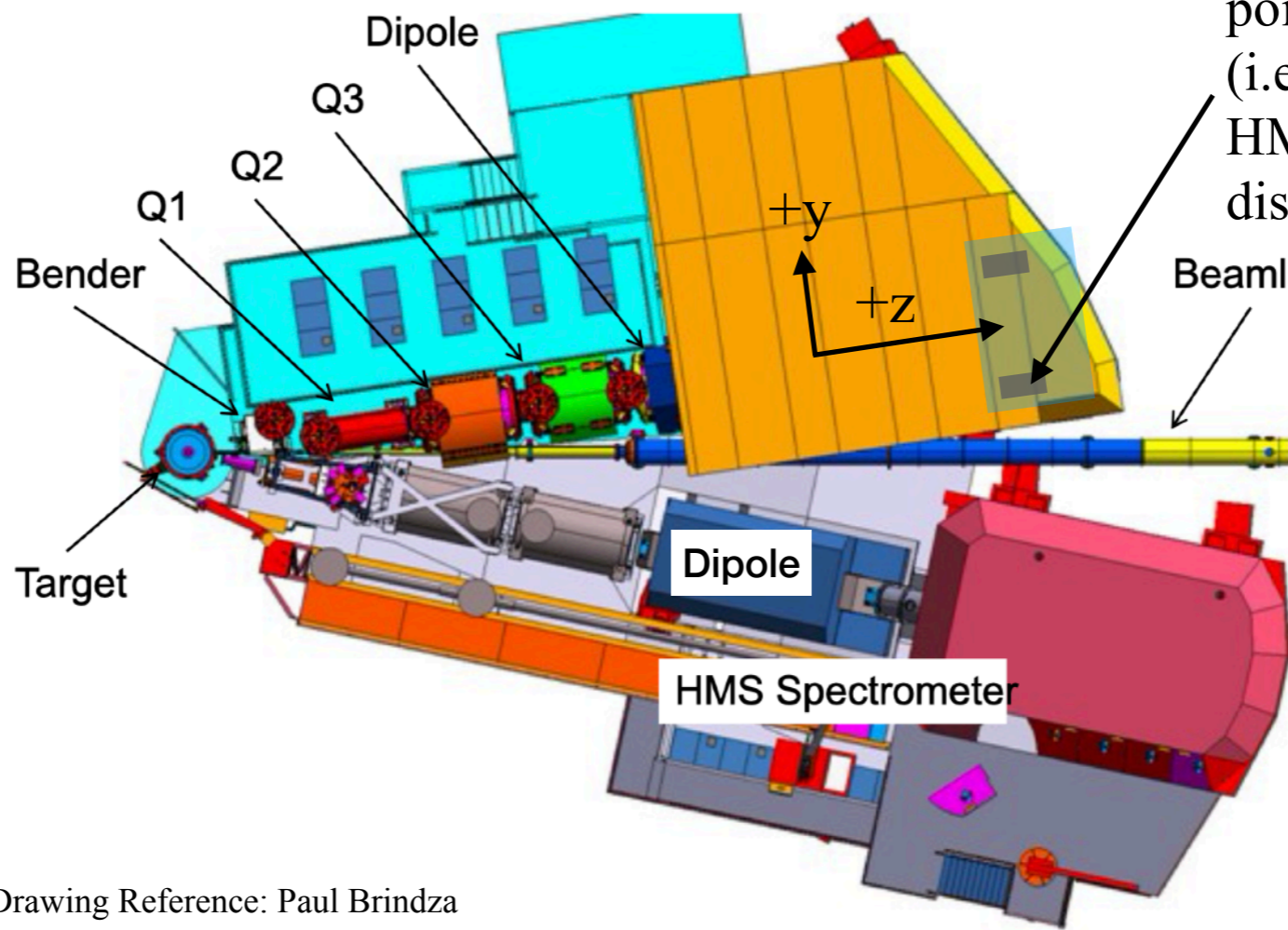
t:g.evnum



fADC Pulse Integral vs. Event Number



Top View SHMS & HMS Spectrometers

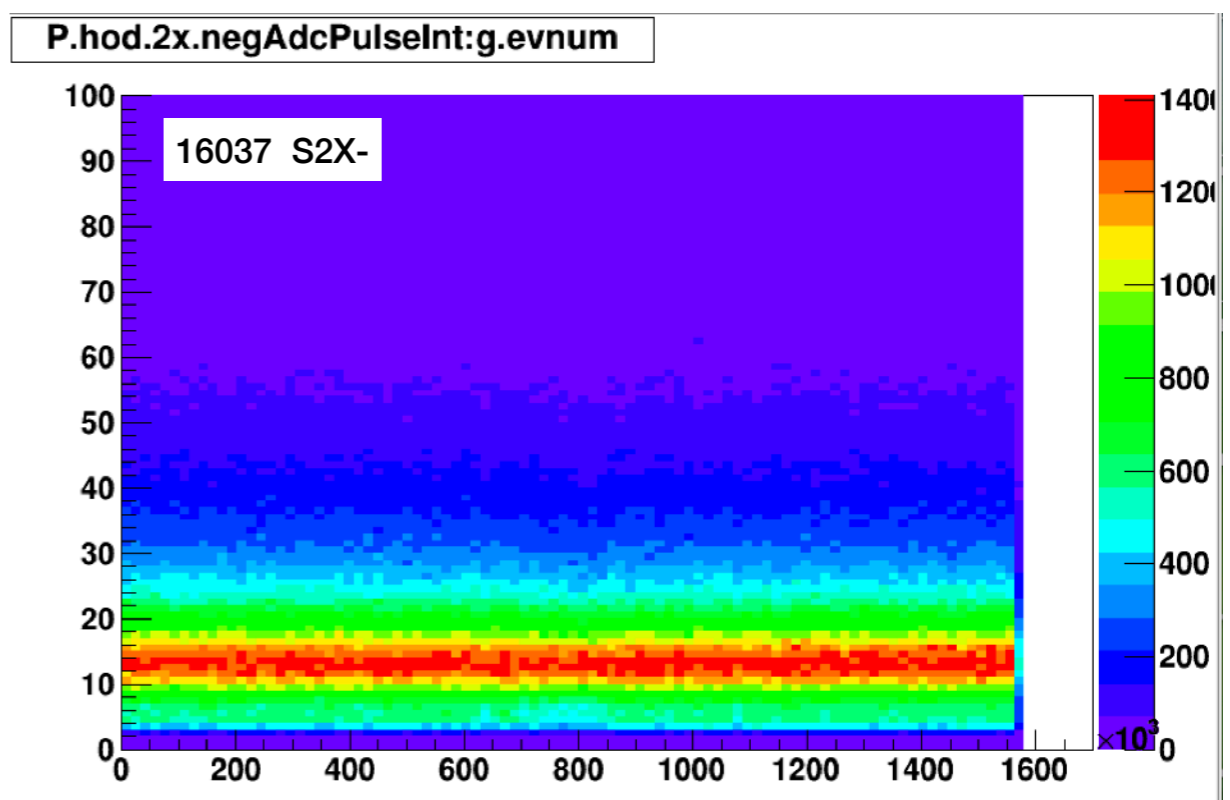
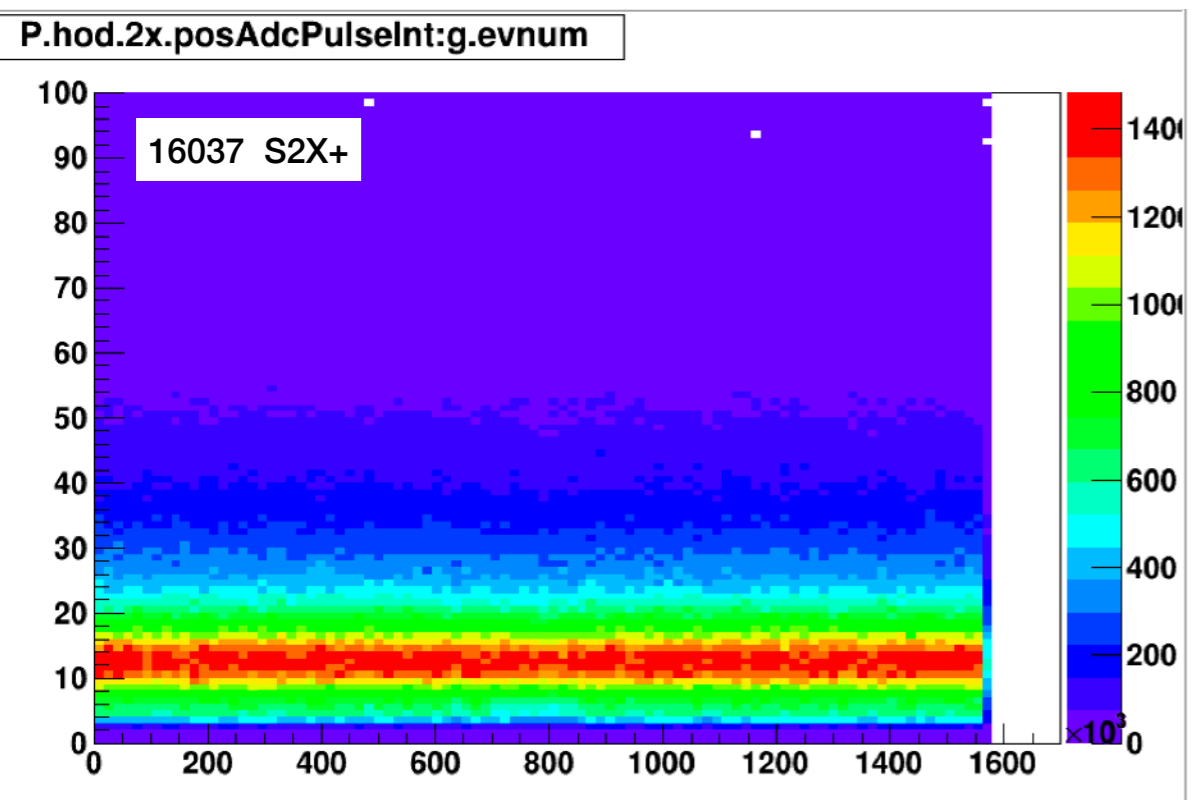
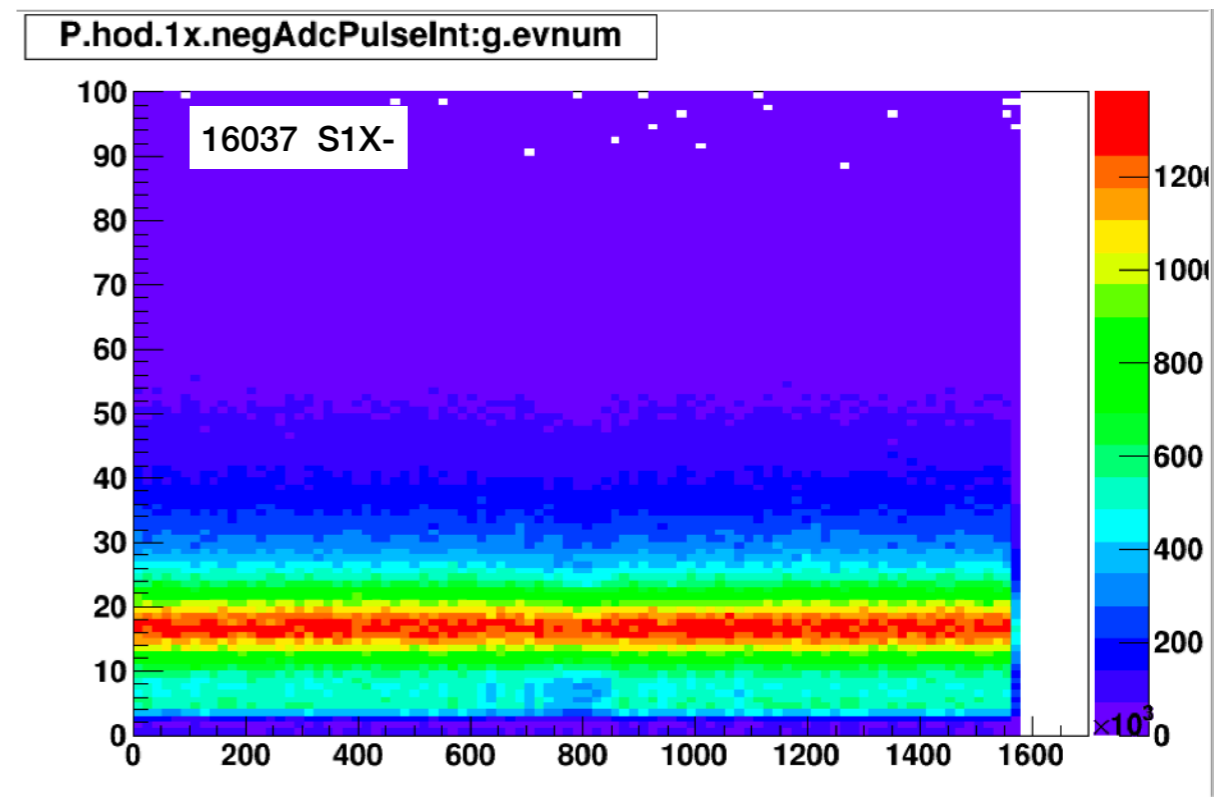
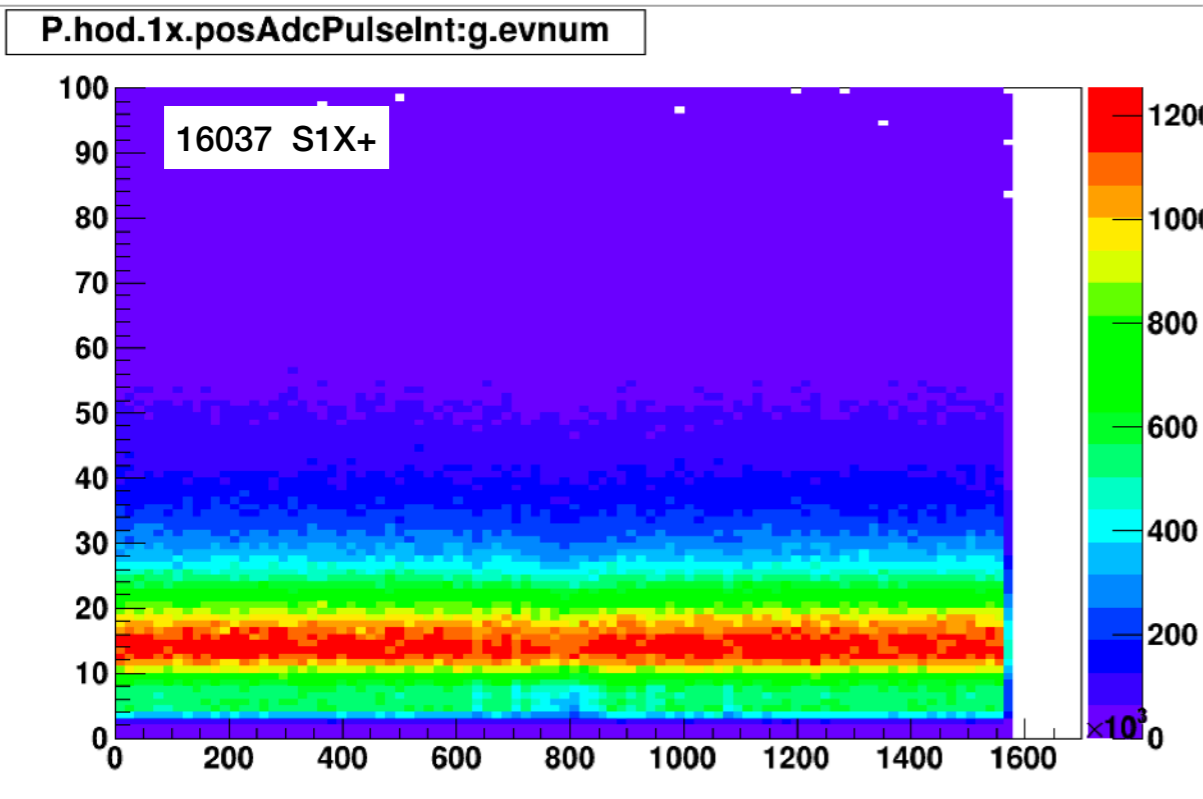


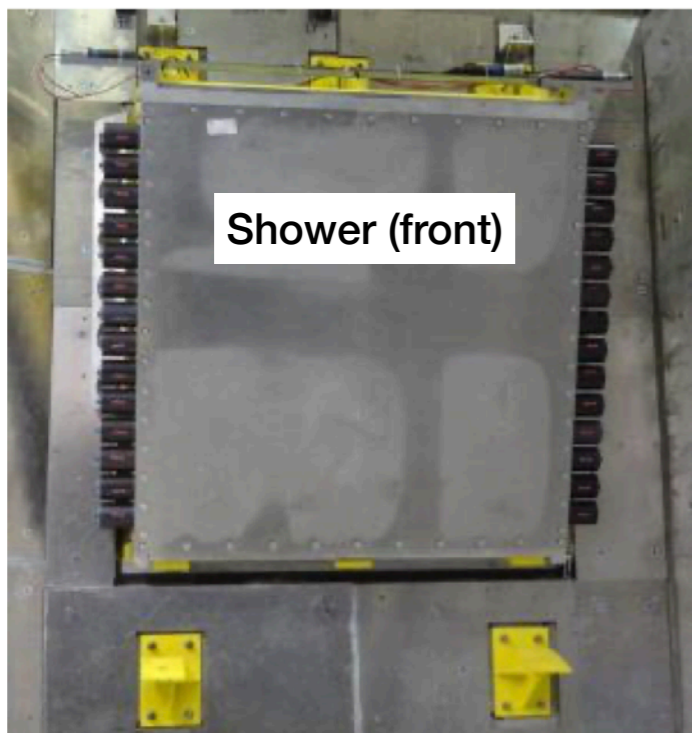
pre-Shower (-) PMTs point towards beamline (i.e., more sensitive to HMS fringe fields or distorted beamline e-)

Drawing Reference: Paul Brindza

Could have the right side of other detectors (i.e., Hodoscope S1X -, S2X- also been affected? (see next slide)

Hodoscopes fADC Pulse Integral vs. Event Number





Shower (front)



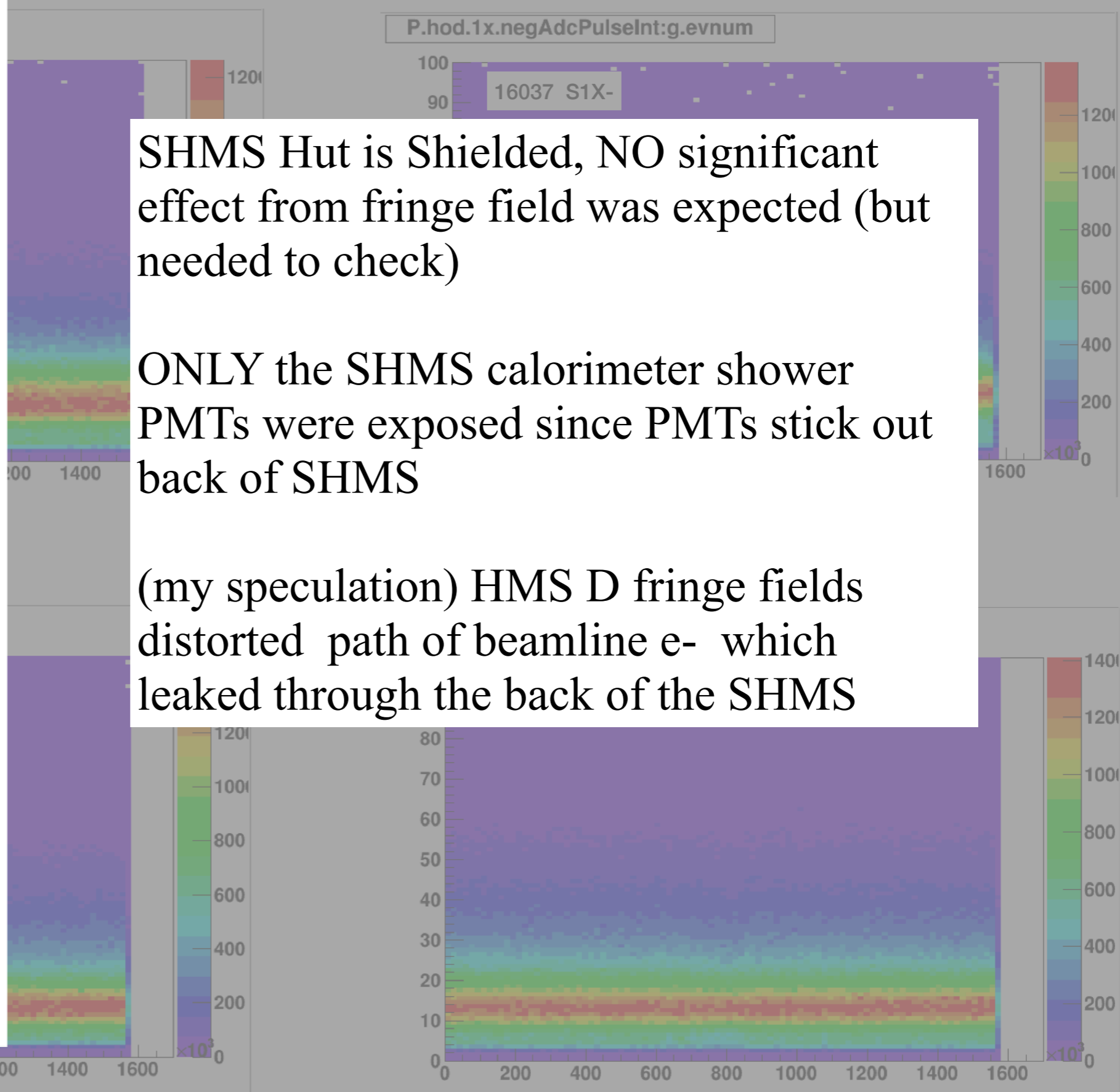
Shower (back)

Picture Ref: Hamlet Mkrtyan

SHMS Hut is Shielded, NO significant effect from fringe field was expected (but needed to check)

ONLY the SHMS calorimeter shower PMTs were exposed since PMTs stick out back of SHMS

(my speculation) HMS D fringe fields distorted path of beamline e- which leaked through the back of the SHMS



Implications on SHMS Hodo HV Study

- Calorimeter (**shower** + **pre-shower**) PMTs HV, and hence, fADC signal subject to HMS fringe fields during run 16037
 - **pre-Shower** (in hardware trigger),
 - * T2 (SHMS EL-REAL) trigger counts affected ?
 - * T1 (SHMS 3/4 trigger counts not affected (use as benchmark))
 - **shower** (not in hardware trigger) but . . .
(calorimeter energy was affected => software cut changes)

need to quantify effect on invariant mass W counts !

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Study 1: Quantify effect of HMS fringe fields on T2 scaler counts

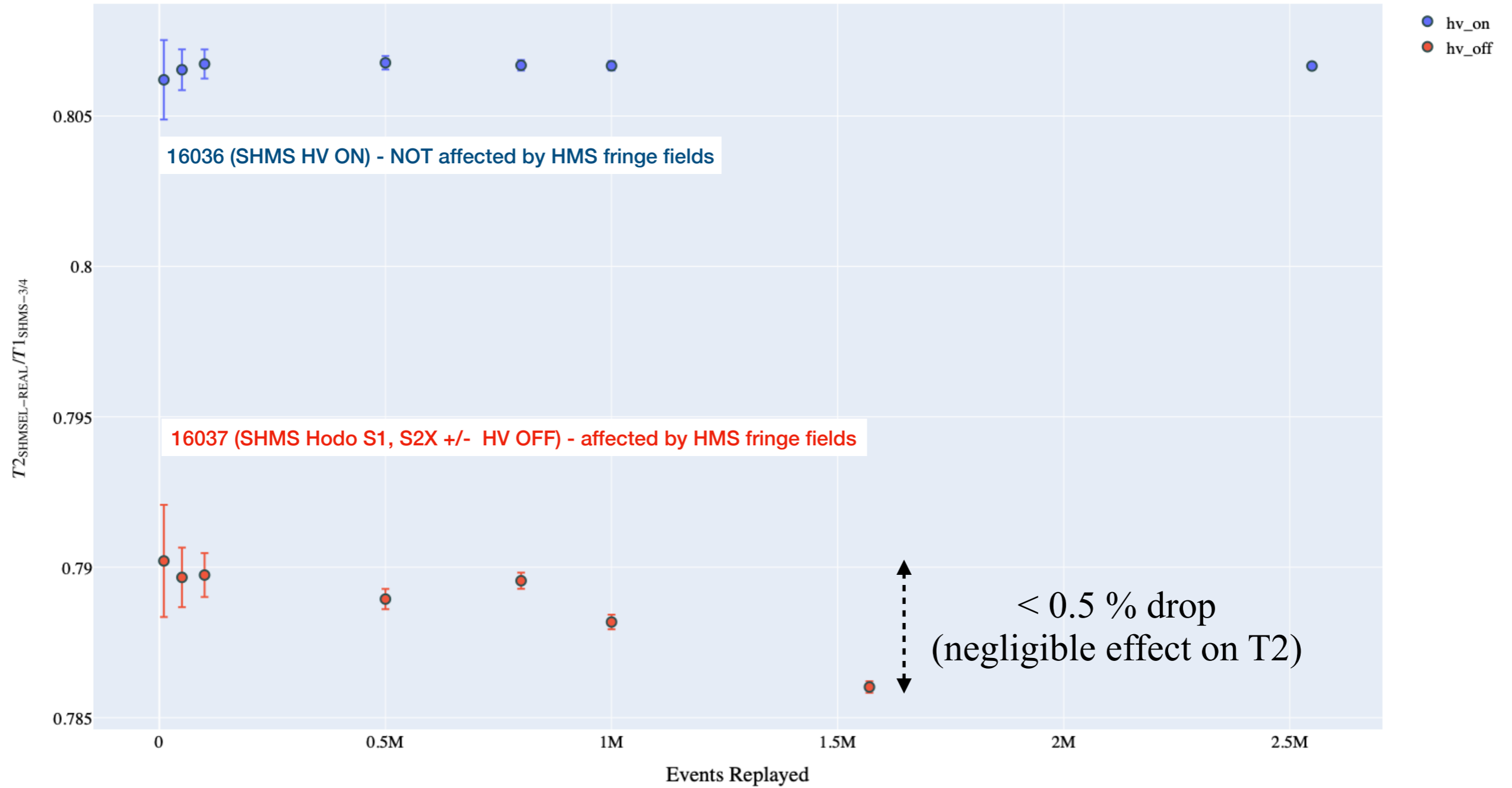
(calorimeter energy was affected => software cut changes)

- Ratio T2 (SHMS EL-REAL) / T1 (SHMS 3/4) vs. Events Replayed

- * T1 (unaffected by fringe) used as benchmark to compare to affected T2
- * T2 more restrictive trigger => T2 Counts < T1 Counts
- * $T2 / T1 = \text{constant}$ (within error) for any given event sample replayed (if T2 affected by fringe field, it should drop relative to T1)

Scaler Counts Ratio T2 / T1

Ratio SHMS EL-REAL to Scin. 3/4 Scaler Counts



Study 2: Quantify effect of HMS fringe fields on elastic counts W

- Ratio W (run 16037) / W (run 16036) vs. Events Replayed

- * elastic counts defined as: integrated W [0.85, 1.05] GeV

- * charge normalized and pre-scale accounted for => W * pre-scale/charge (counts/mC)

- pre-Shower (in hardware trigger),

- * T2 (SHMS EL-REAL) trigger counts affected ?

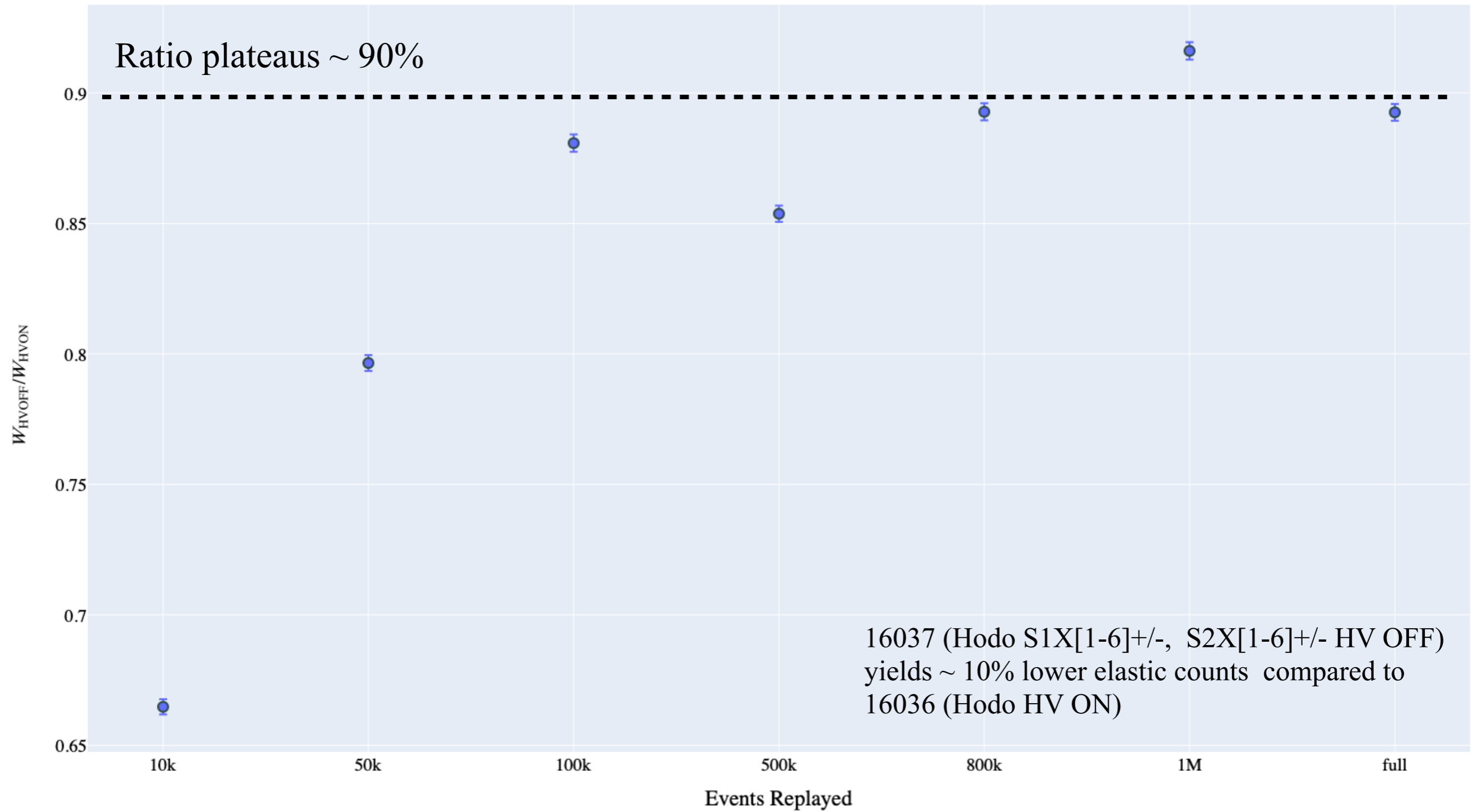
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- shower (not in hardware trigger) but . . .

- (calorimeter energy was affected => software cut changes)

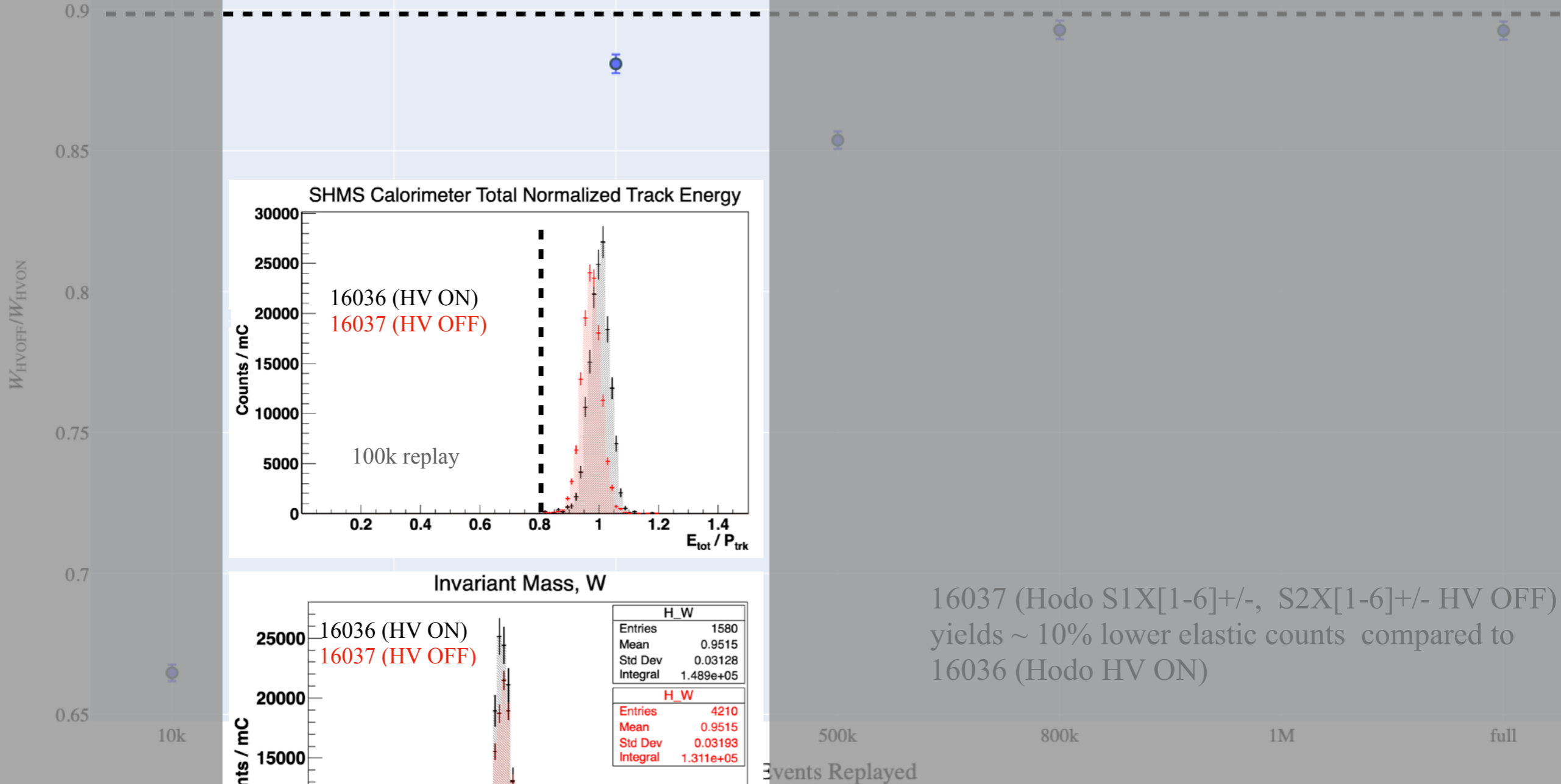
need to quantify effect on invariant mass W counts !

Ratio of Invariant Mass W



Ratio of Invariant Mass W

Ratio plateaus ~ 90%



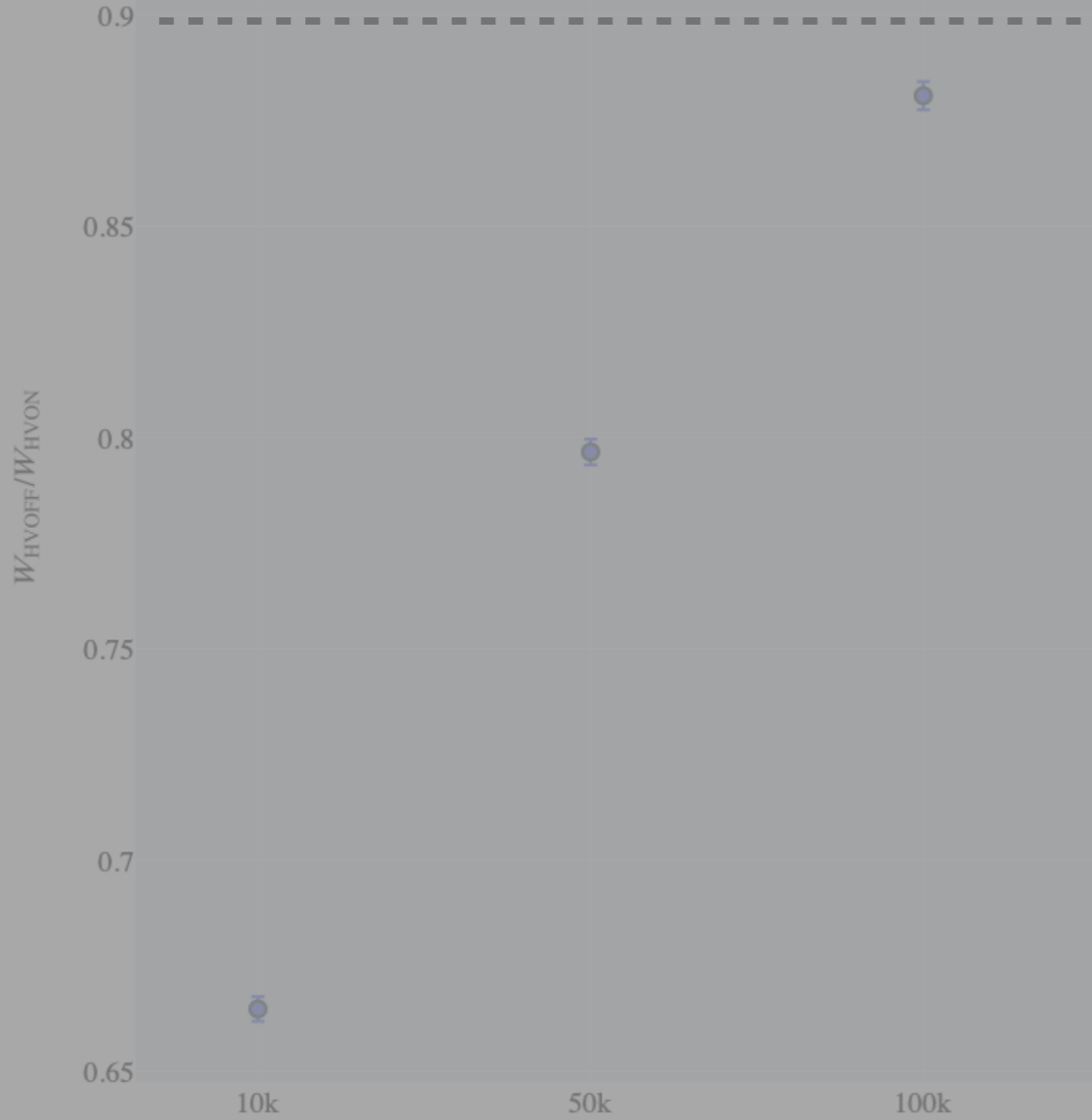
16037 (Hodo S1X[1-6]+/-, S2X[1-6]+/- HV OFF) yields ~ 10% lower elastic counts compared to 16036 (Hodo HV ON)

H_W	
Entries	1580
Mean	0.9515
Std Dev	0.03128
Integral	1.489e+05

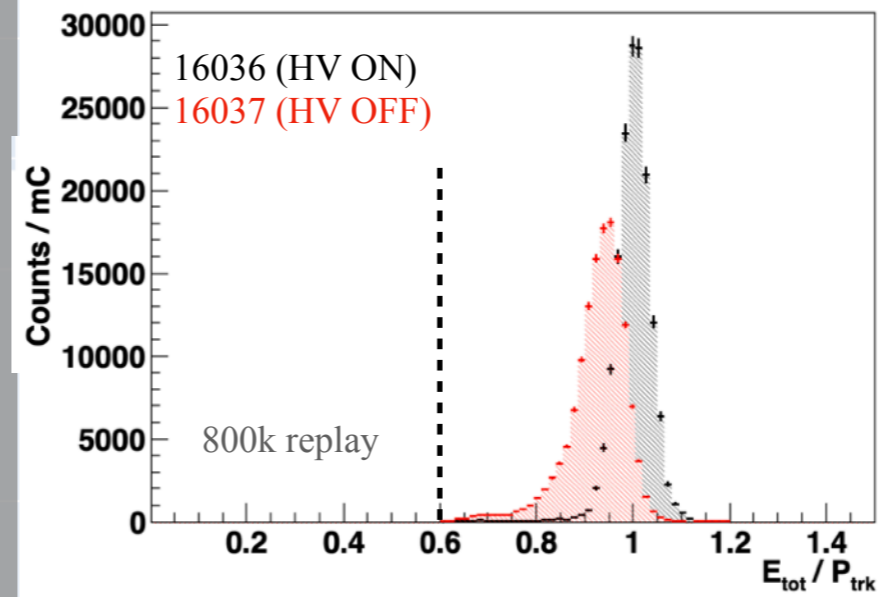
H_W	
Entries	4210
Mean	0.9515
Std Dev	0.03193
Integral	1.311e+05

Ratio of Invariant Mass W

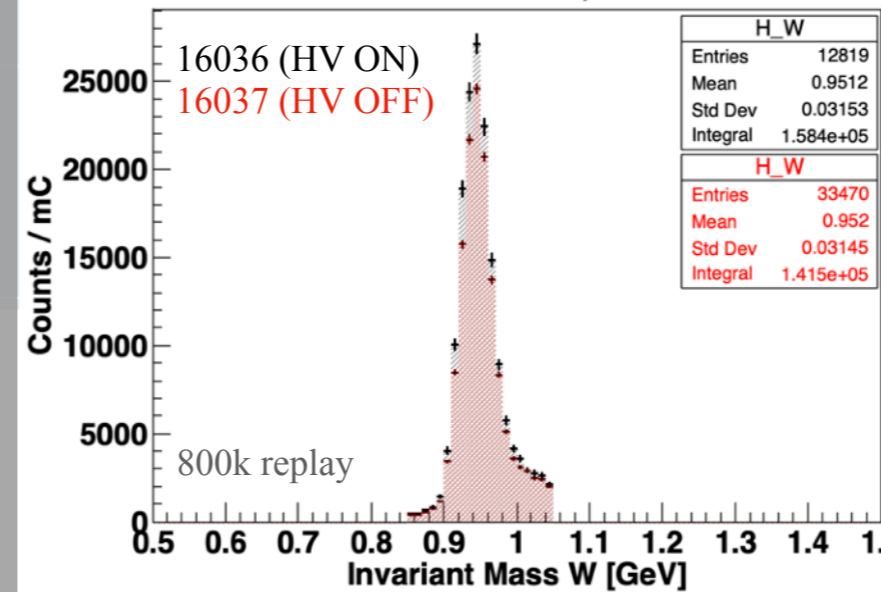
Ratio plateaus ~ 90%



SHMS Calorimeter Total Normalized Track Energy



Invariant Mass, W

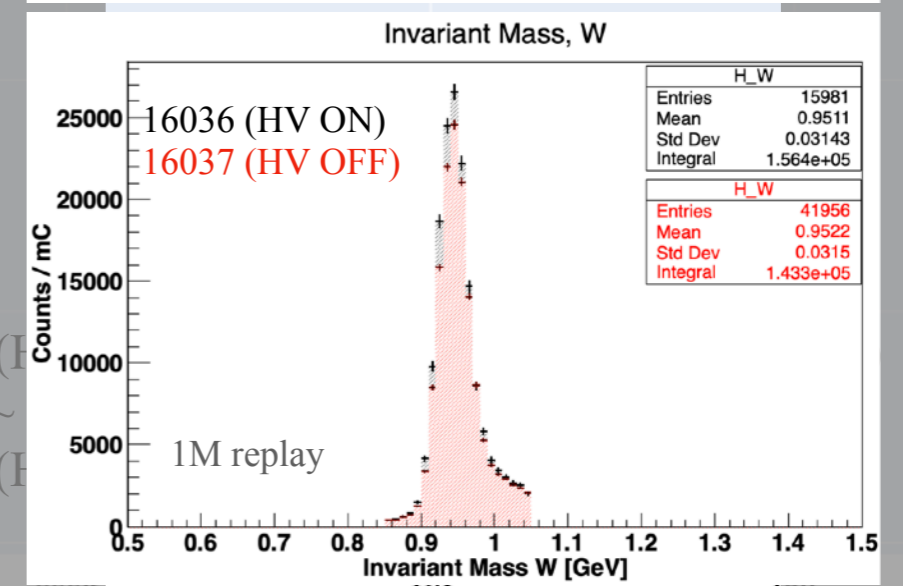
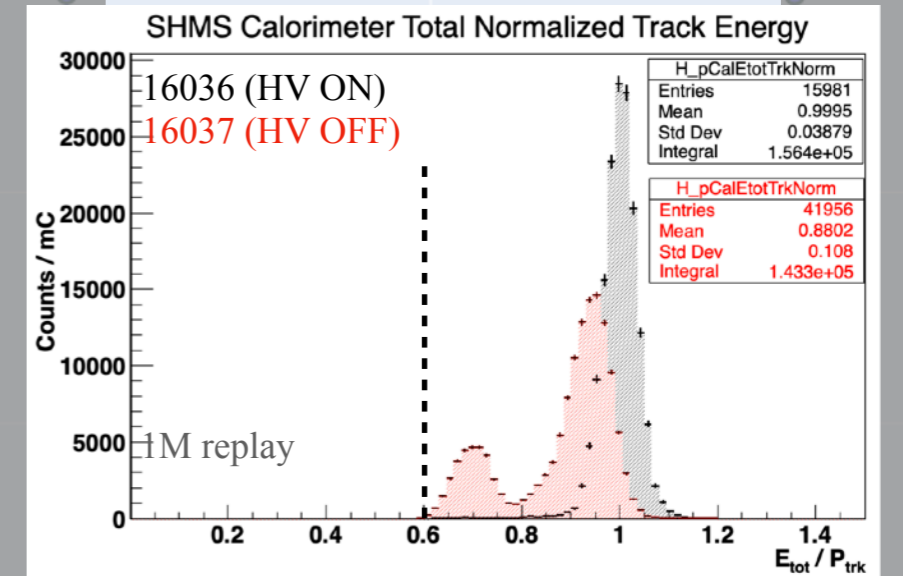
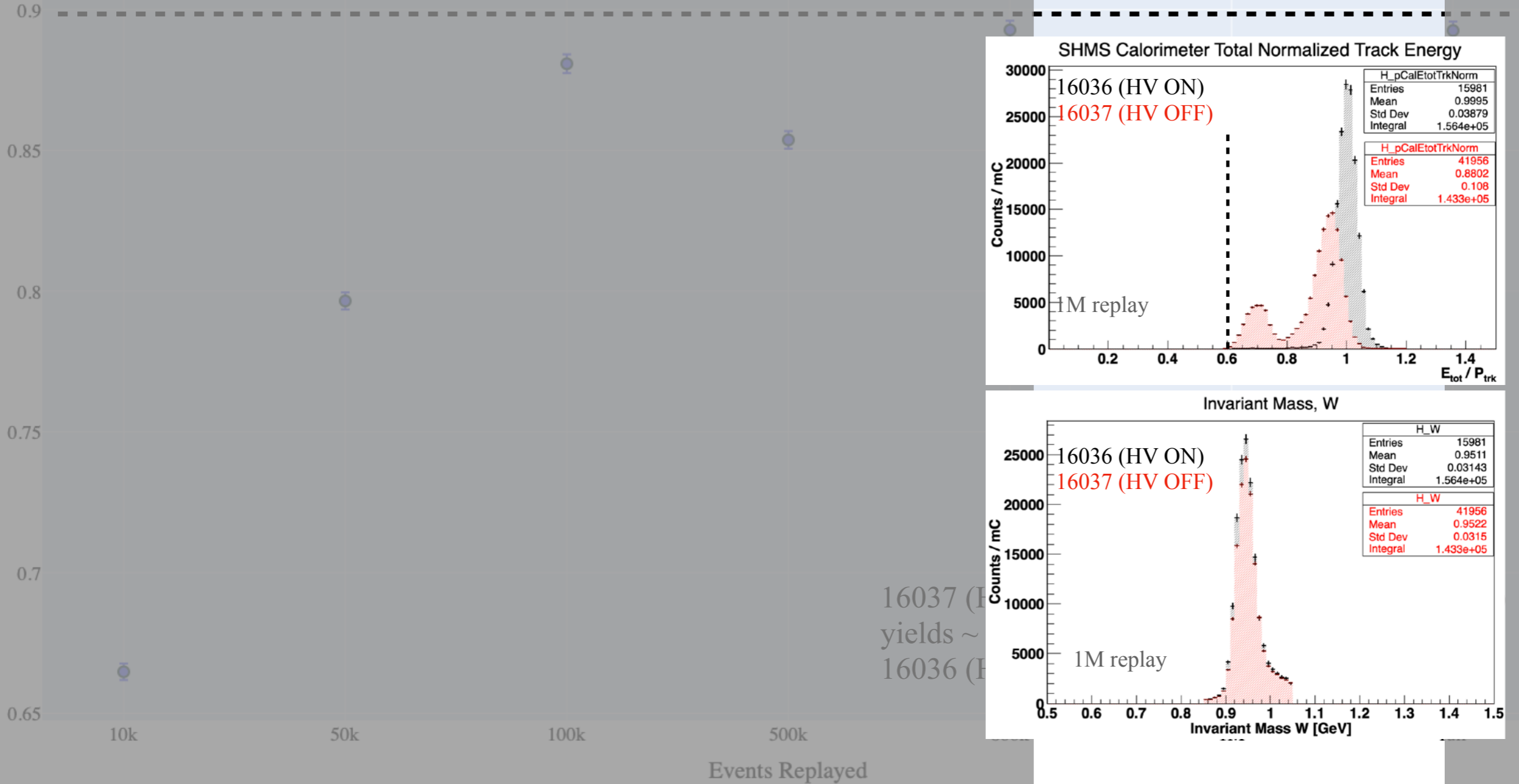


S2X[1-6]+/- HV OFF)
counts compared to

IM full

Ratio of Invariant Mass W

Ratio plateaus ~ 90%



16037 (HV OFF)
yields ~
16036 (HV ON)

Summary

- HMS fringe fields impacted CaFe run 16037 (SHMS Hodo HV OFF)
- Only SHMS Shower calorimeter was significantly impacted (i.e., needed to modify software cut)
- $H(e, e')$ singles elastic counts $\sim 10\%$ lower for HV OFF compared to HV ON

What is causing $\sim 10\%$ discrepancy in our data ?

- simulation may have over-estimated the effect of turning OFF hodoscope paddles?

- even though no apparent issues due to HMS fringe fields were found, this study should be re-taken during CaFe, but with the following conditions:

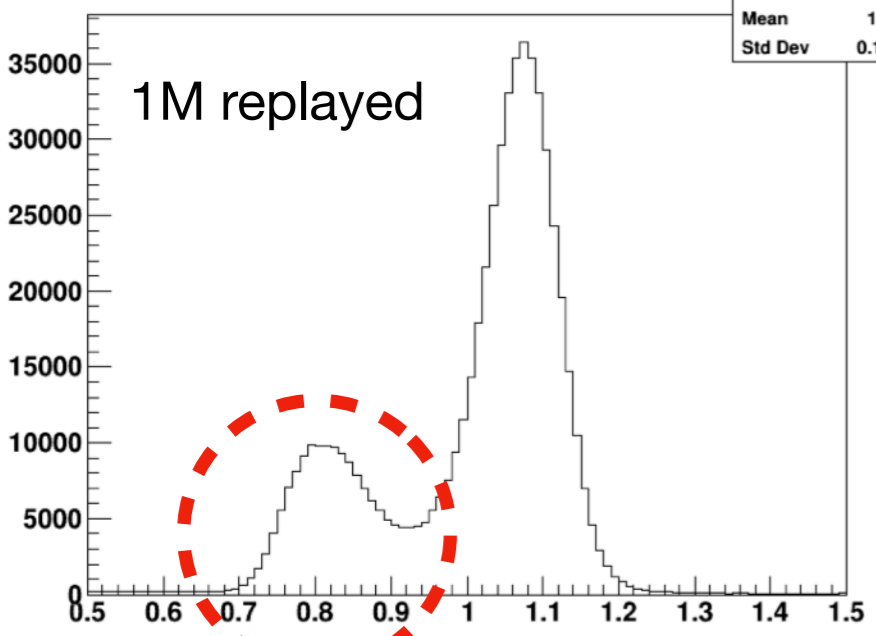
1) only coincidence trigger

2) allow one more scintillator paddle in S1X, S2X to be ON (i.e., S1X[1-5], S2X[1-5] HV OFF)

Back-Up Slides

P.cal.etottracknorm

h1M	
Entries	1000000
Mean	1.007
Std Dev	0.1223



ary.W:P.cal.etottracknorm

Entries	1000000
Mean x	1.005
Mean y	1.226
Std Dev x	0.1307
Std Dev y	0.2037

